§3. Release of Integrated Transport Suite for LHD Experimental Analysis, TASK3D-a

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The LHD plasmas have extended its parameter regime [1]. The energy confinement property has been analyzed mainly on topics-oriented basis. On the other hand, the unified energy confinement scaling law for helical plasmas was deduced as ISS95 [2] and its extension, ISS04 [3], where the global energy confinement time was discussed. Extending physics understandings for the energy confinement beyond a scaling law is mandatory to increase the predictability for further enhancement of the plasma performance in present experiment, and then to design fusion-reactor scenario. For this purpose, an integrated transport analysis suite, named TASK3D-a (analysis version), has been developed.

The calculation procedure employed in TASK3D-a ("a01" as the first version) is schematically shown in Fig. 1. It consists of 4 parts, LHD Data interface, 3D equilibrium, heating, and energy/momentum balance analysis.

LHD data interface is based on real-time coordinate mapping system, TSMAP [4], in which radial coordinate is transformed from the real coordinate to the effective minor radius (r_{eff}) by searching "best-fit" equilibrium in pre-calculated VMEC [5] database. Here, the "best-fit" is meant to satisfy the in-out symmetry (with respect to the magnetic axis position ~ peak of the electron temperature, T_e) of the measured T_e profile. Based on the coordinate mapping, T_e and density profiles are provided as a function of r_{eff}, and ion temperature (T_i) profile as well when it is measured.

3D equilibrium part re-evaluates VMEC equilibrium for all the timings of strong Thomson lasers (for T_e measurement), by implementing parameters for the pressure and current profile of a "best-fit" TSMAP at each time slice. Calculated equilibrium does not necessarily mean all of the equilibrium properties are well reproduced. Thus, it should be considered this approach is just one of practical approaches for providing equilibrium for analysis.

Heating part includes only NBI module at this moment. The "fit3d" has been developed to evaluate radial profiles of NBI absorbed power, beam pressure, beam source and induced momentum [6]. It should be noted that T_i is not always measured for selected timings. Thus, $T_i = T_e$ is assumed for a standard use of TASK3D-a01, based on known rather small influence of T_i on the deposition properties. The results are stored as "*eg*" file format on Kaiseki Data Server of LHD experiment [7].

The "conv_fit3d" has been developed [8] to evaluate the NBI absorbed power and induced momentum by taking the beam slowing-down (SD) effect into account, based on the results obtained by "fit3d".

It should be noted that time-dependent GNET (GNET-TD [9]) calculations have become available. Benchmarking between the approach in combination with "fit3d" and "conv_fit3d" and that of GNET-TD will be performed.

Energy balance analysis part consists of two modules, "TRsnap" [10] (for steady-state analysis) and "dytrans" [11] (for so-called dynamic transport). The "TRsnap" has been modified based on TASK/TR (module of TASK [12]). Power input from NBI and the collisional energy transfer is taken into account in the energy balance. Other terms such as radiation loss and charge exchange loss have been ignored. The "dytrans" evaluates, in addition to the steady-state energy flow, the energy flows due to the temporal variation of plasma profiles. Thus, the temporal behavior of energy confinement property in transient plasmas can be analysed, such as to identify when confinement improvement occurs.

In this way, analyses on energy confinement of LHD plasmas can be significantly accelerated through the TASK3D-a.

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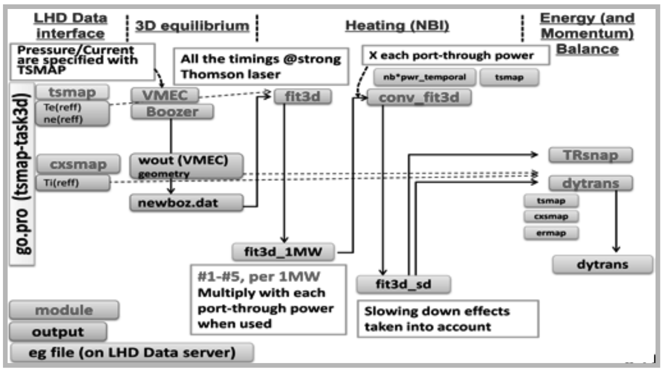

Fig.1 Calculation procedure employed in TASK3D-a01.